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Gov't Agency Developed by: National Aeronautics and Space Administration (NASA)

Paper Title: Robot Assisted Microsurgery -- New Technologies that Enhance and Extend Surgical Skills

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Category: Medical Technology

Description: Robotic technologies have recently attracted widespread interest within the medical community [1]. Several complementary directions of robotic-assisted surgery are being explored; these include robotically-automated stereotactic interventions (imaging-guided biopsy), orthopedic preparations by robot (precision joint emplacements), endoscopic & laparoscopic assists (minimally invasive procedures), teleoperative remote surgeries ("telesurgery"), and very recently, robotic microsurgery (eye-ear-fiace-hand).

Drawing on a established technology base in high-fidelity teleoperation/telepresence [2, 3, 4], JPL has begun development and commercialization of a new robotic platform for dexterity-cnbanced microsurgery, in cooperation with MicroDexterity Systems, Inc., Memphis, TN, and leading surgeons, Our goal is to develop a master-slave telerobot and sensor-based shared controls that refine the scale of current microsurgical procedures, and enable positive outcomes for more surgeons doing typical procedures. We will report our progress on a new JPL 6 d.o.f. surgical robot (slave) having a torso-shoulder-elbow body geometry and intersecting 3-axis wrist configuration. The robot is approximately 40 cm. in ful]-extent; robot actuation is based on a new revolute joint and cable-drive mechanism providing near zero backlash, constant cable length excursions, and minimized joint coupling. This mechanical design and associated controls will allow relative positioning of surgical tools to within 10-20 microns in a work volume of 8-10 cm*3 -- surgeons will be able to clown-scale their hand motion inputs by 2-to-3x, thus performing break-through procedures in such critical areas as vitreo-retinal (inner eye) surgeries. We will summarize our planned fut urc development of the overall master-slave microdexterit y system with force and tactile feedback at the surgeon's hand-controller, including a teleoperator controls design to enhance positioning performance in the face of myoclonic jerk and tremor limiting most practitioners' skills.

References

1) See, for example: Proceedings of Medicine Meets Virtual Reality, June 4-7, and Medicine Meets Virtual Reality 11, Jan 27-30, 1994, both at San Diego, California, sponsored by Univ. Calif. San Diego (Publisher: Aligned Management Consultants, San Diego, CA.).

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3) P. S. Schenker, A. K. Bejczy, W. S. Kim, and S. Lee, "Advanced man-machine interfaces and control architecture for dexterous teleoperations," in Proc. Oceans '91, pp. 1500-1525, Honolulu, 111, October, 1991; see also, W. S. Kim and P. S. Schenker, "Teleoperation training simulator with visual and kinesthetic force reality," in Human Vision, Visual Processing, and Visualization, Proc. SPIE 1666, San Jose, CA, February 1992.

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Principal Author Biography

Dr. Paul S. Schenker is Group Supervisor, Man Machine Systems, Jet Propulsion Laboratory, California institute of Technology, leading developments of robot design, sensor-based robot controls, 3-D graphics/VR interfaces, computing architectures, and their human-factors based evaluation for space and commercial applications, 1 Ie currently manages NASA tasks on robot assisted microsurgery, ground operations interfaces for space robotics, and a cooperative NASA-MIT1R&D program in telerobotics.

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